



## ABSTRACT

This user's guide describes the setup and use of the TPS929160EVM evaluation module (EVM). This EVM helps the user evaluate the features of the Texas Instruments TPS929160-Q1, which is an automotive 16-channel LED driver with FlexWire interface, to address increasing needs of individual control of each LED string. This document includes hardware setup instructions, software instructions, a schematic diagram, a bill of materials and printed-circuit board layout drawings.



### WARNING

**Hot surface! Contact may cause burns. Do not touch!**

Some components may reach high temperatures  $>55^{\circ}\text{C}$  when the board is powered on. The user must not touch the board at any point during operation or immediately after operating, as high temperatures may be present.

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### Trademarks

All trademarks are the property of their respective owners.

## 1 What You Get

The TPS929160EVM kit (Figure 1-1) contains:

- USB2ANY
  - Ribbon cable
  - USB cable
- TPS929160EVM
- TPS929120CANEVM
- DB-09 cable



Figure 1-1. TPS929160EVM Kit

## 2 What You Need In Addition

The following additional items are required to run the TPS929160EVM:

- PC with TPS929160EVM GUI installed or to run the on-line TPS929160EVM GUI
- 12-V DC power supply

## 3 How to Get Started

### 3.1 Hardware Setup

There are two hardware setups to simulate the communication between MCU and TPS929160-Q1 directly or through CAN transceiver. And TPS929160EVM contains a buck in the board. You can decide whether to use it by "J66", "J31".

#### 3.1.1 Communication without CAN Transceiver

Figure 3-1 shows the hardware setup when TPS929120CANEVM is not used. Figure 3-2 shows the jumper configurations for the TPS929160EVM without TPS929120CANEVM connected. This jumper is the default jumper configuration shipped with the board.

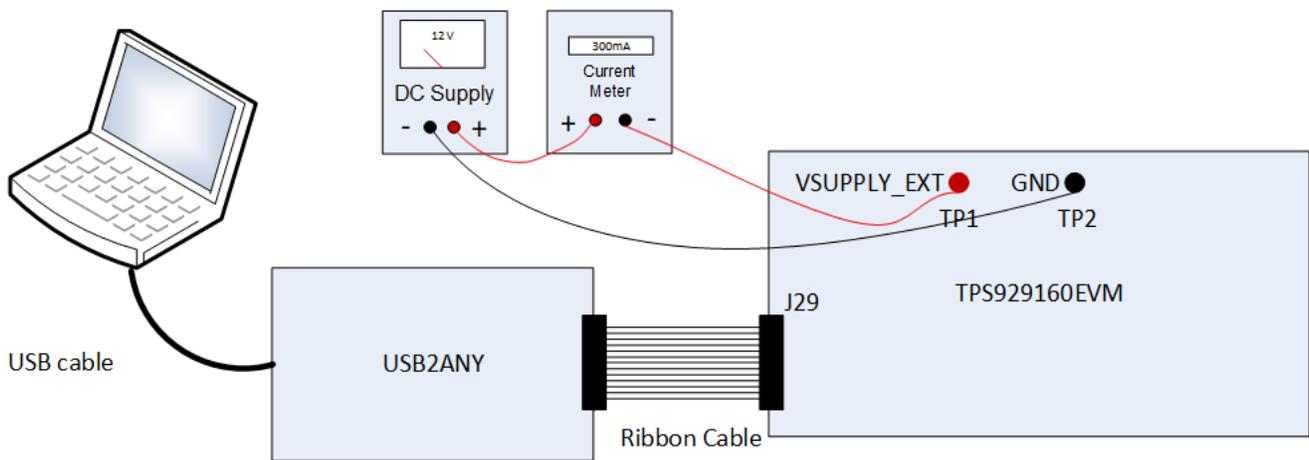


Figure 3-1. Hardware Setup without CAN Transceiver

- Connect a 12-V power supply to TP1 (VSUPPLY\_EXT) and TP2 (GND).
- Connect USB2ANY tool to PC through the USB cable.
- Connect USB2ANY tool to the J4 connector of TPS929160EVM through ribbon cable.

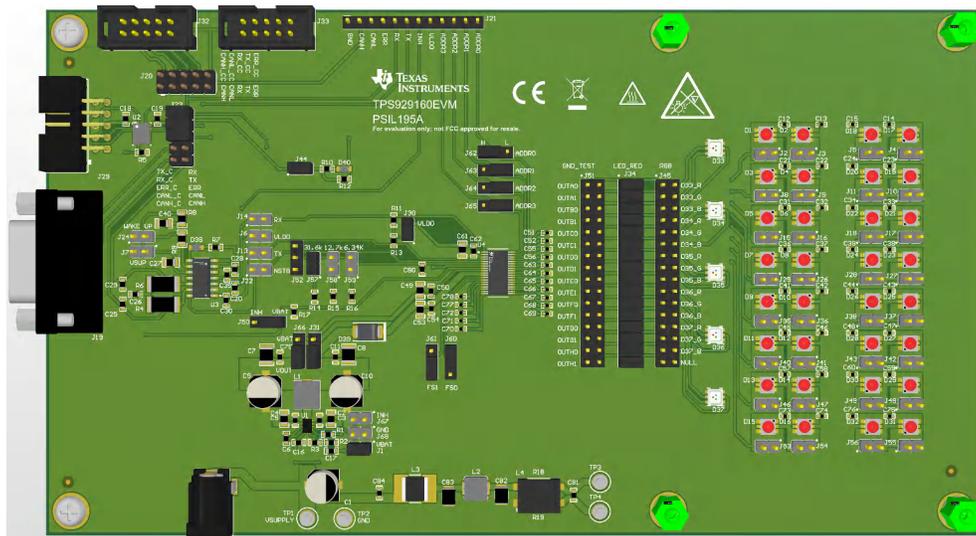


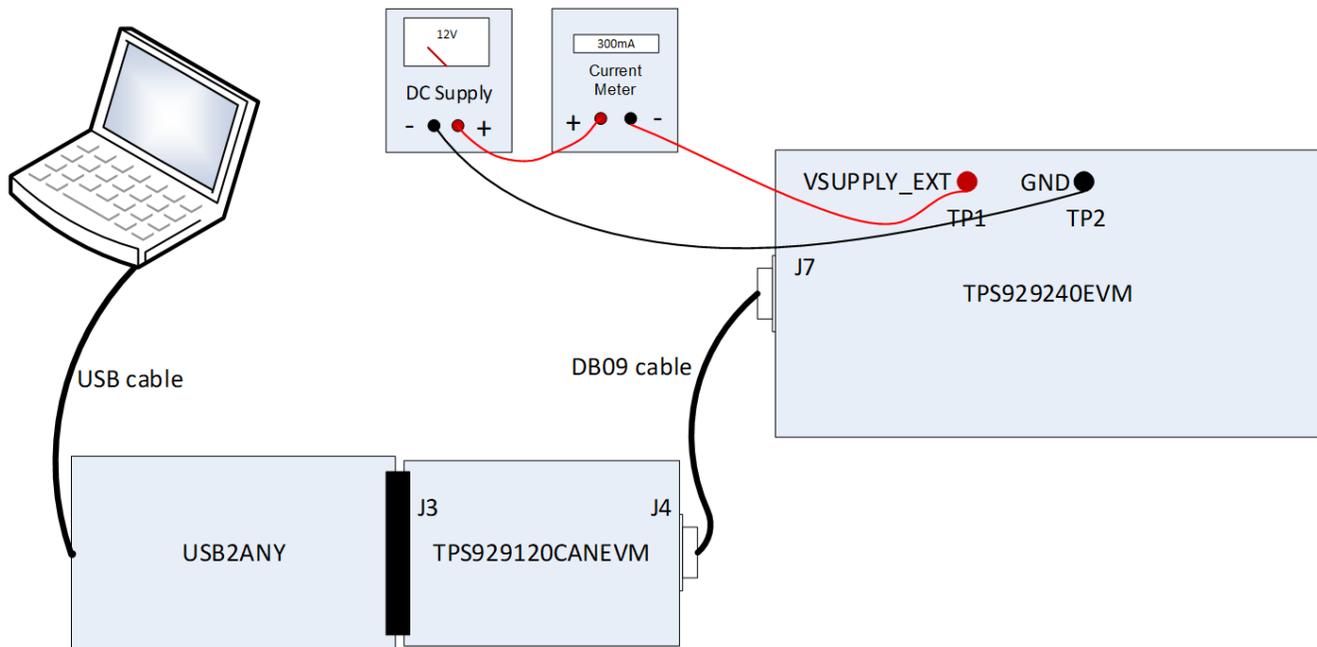
Figure 3-2. TPS929160EVM Jumper Configurations without TPS929120CANEVM Connected

**Table 3-1. TPS929160EVM Jumpers Setting without TPS929240CANEVM Connected**

HEADER	SETTING
J44, J30, J57, J1	Short
J20, J7, J24, J14, J6, J13, J22, J52, J58, J59, J67, J68, J51, J45	Open
J23	Short "TX_C" to "RX", "RX_C" to "TX", "ERR_C" to "ERR"
J64	Short "ADDR2" to "L"
J63	Short "ADDR1" to "L"
J62	Short "ADDR0" to "H"
J60	Short "FS0" to "H"
J61	Short "FS1" to "L"
J31, J66	Short to "VOUT"
J50	Short to "VBAT"
All headers paralleled with LEDs	Open

### 3.1.2 Communication with CAN Transceiver

Figure 3-3 shows the hardware setup when TPS929120CANEVM is used. Figure 3-4 shows the jumper configurations for TPS929160EVM with TPS929120CANEVM connected.


**Figure 3-3. Hardware Setup with CAN Transceiver**

- Connect a 12-V power supply to TP1 (VSUPPLY\_EXT) and TP2 (GND).
- Connect USB2ANY tool to PC through USB cable.
- Plug TPS929120CANEVM to USB2ANY tool through the J3 header of TPS929240CANEVM.
- Connect TPS929120CANEVM to TPS929160EVM through the J4 connector of TPS929240CANEVM and the J7 connector of TPS929160EVM with DB-09 cable.

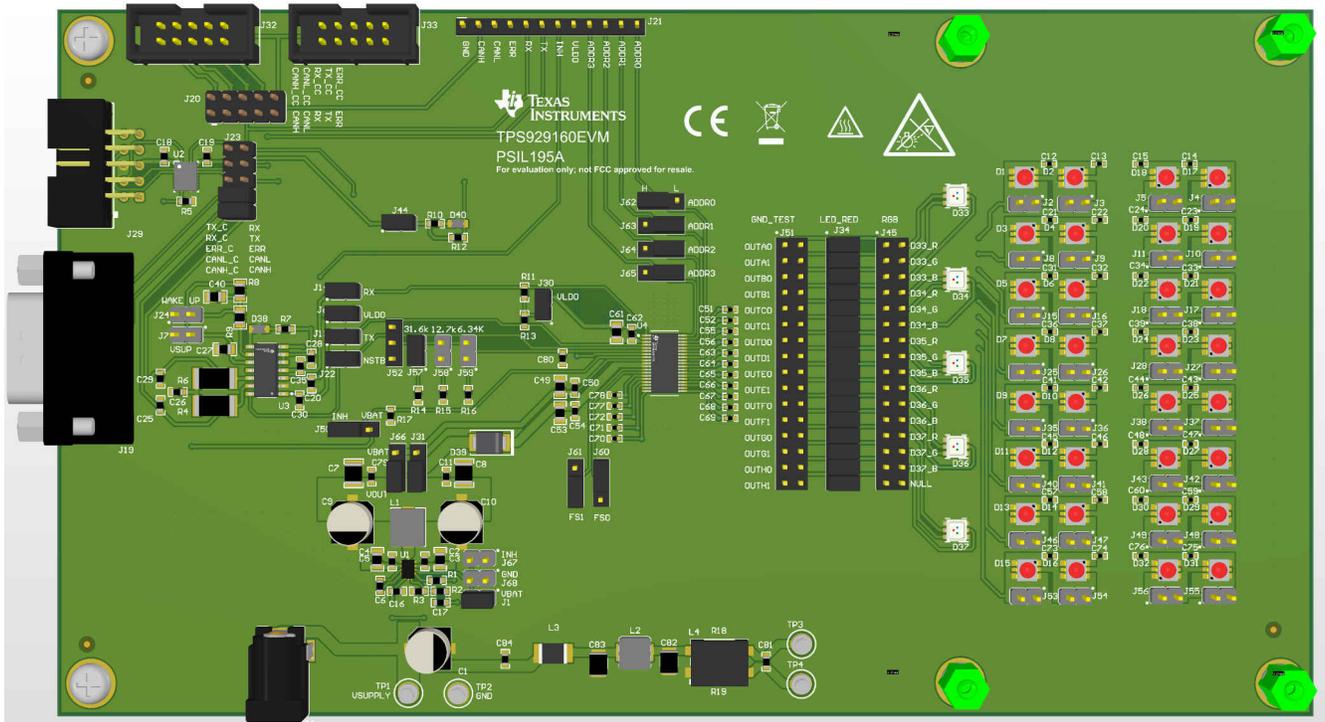
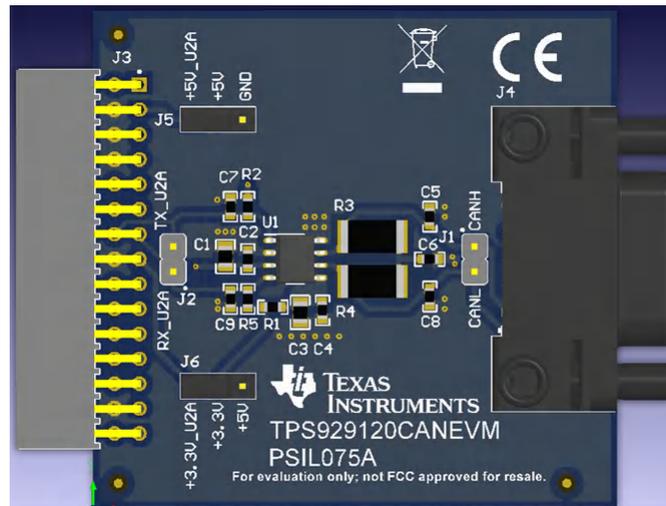


Figure 3-4. TPS929160EVM Jumper Configurations with TPS929120CANEVM Connected

Table 3-2. TPS929160EVM Jumpers Setting with TPS929240CANEVM Connected

HEADER	SETTING
J44, J30, J7, J14, J6, J13, J22, J57, J34, J67	Short
J20, J52, J58, J59, J51, J45, J24, J1, J68	Open
J23	Short "CANH_C" to "CANH", "CANL_C" to "CANL"
J65	Short "ADDR2" to "L"
J64	Short "ADDR2" to "L"
J63	Short "ADDR1" to "L"
J62	Short "ADDR0" to "H"
J60	Short "FS0" to "H"
J61	Short "FS1" to "L"
J31, J66	Short to "VOUT"
J50	Short to "INH"
All headers paralleled with LEDs	Open

Figure 3-5 shows the jumper configurations for TPS929120CANEVM. For header J5, short "+ 5 V" to "+ 5 V\_U2A". For header J6, short "+ 3.3 V" to "+ 3.3 V\_U2A".



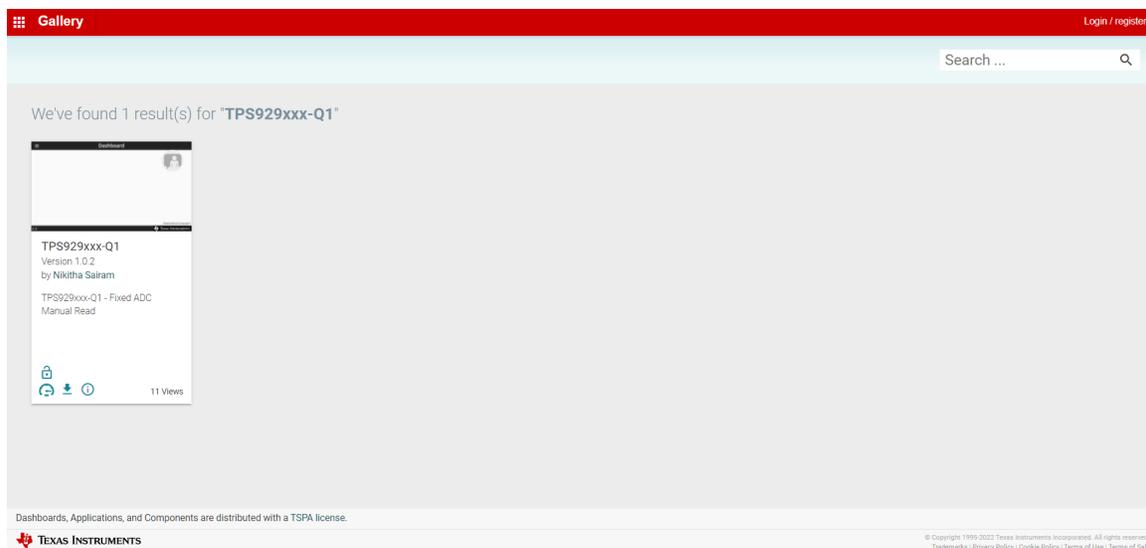
**Figure 3-5. TPS929120CANEVM Jumper Configurations**

## 3.2 Software Installation

There are two types of the GUI, online version and desktop version.

### 3.2.1 Run Applications Through Online

Go to the [TPS929160-Q1 EVM web page](#). Scroll down to the "Order Now" section and click the "Start Evaluation" button to reach to the TPS929160-Q1 gallery page. Login to user account privileges can be required to open the gallery page. All GUI versions are shown ordered from left to right on the gallery page as shown in [Figure 3-6](#). Left most application icon shows the latest version. Clicking the application icon to open the online version GUI. There may be prompt to download and install the browser extension and TI Cloud Agent for the first time. Follow the steps to install the browser extension and TI Cloud Agent Applications.



**Figure 3-6. TPS929160-Q1 Gallery Page**

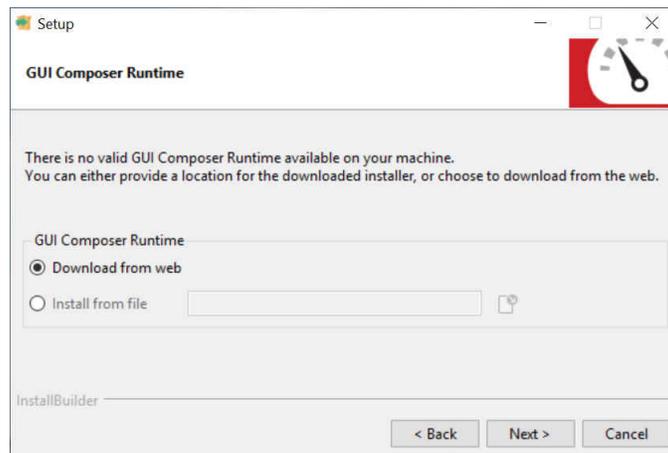
### 3.2.2 Run Applications on Desktop

Click the "Download" button under the "Order Now" section to download the TPS929160EVM GUI installation zip file to local computer, or you can download it from the application icon as showed in [Figure 3-7](#) by hovering the cursor over the download button and selecting the appropriate platform. Then extract the zip folder and install the GUI using the exe - TPS929160-Q1-1.0.5.setup-win\_7.3.0. Make sure the network is connected while installing the GUI.



**Figure 3-7. GUI and GUI Composer Download Page**

Follow the on-screen instructions by clicking the "Next" button to accept the license, default installation directory and to install the GUI Composer Runtime engine. Either provide a location for the downloaded GUI Composer Installer, or choose to download from the web. The GUI Composer Installer can be downloaded from the gallery page as showed in [Figure 3-7](#) by selecting the appropriate platform. Continue to click on the "Next" button to complete the GUI Composer Runtime installation.

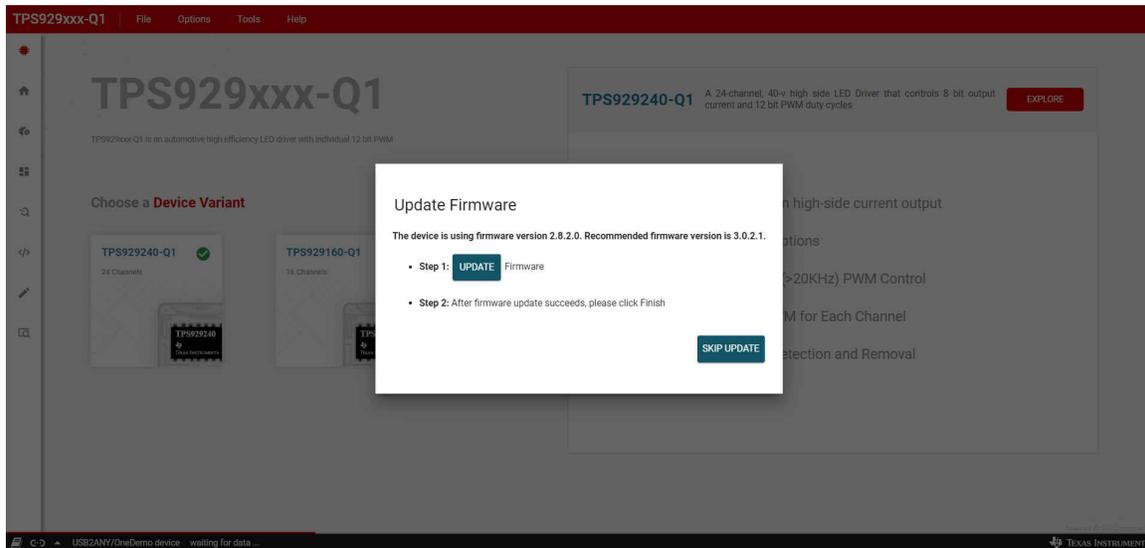


**Figure 3-8. GUI Composer Runtime Installation**

After the GUI Composer installation, it continues to install the TPS929160EVM GUI. Follow the on-screen instructions by clicking the "Next" button to finish the GUI installation. After installed, a shortcut to the GUI is found on the desktop and also in the start-up menu under the Texas Instruments folder.

### 3.3 Firmware Update

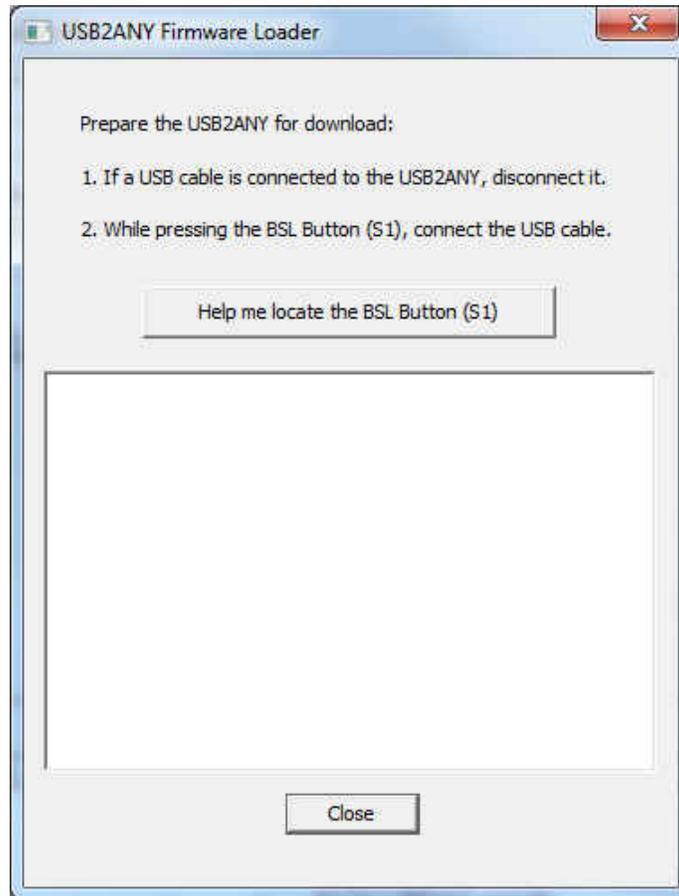
After opening the GUI, the GUI tries to connect the EVM board. At the moment, the GUI detects the firmware version of the connected USB2ANY tool automatically. If the firmware version is not mapping with the recommended version for the GUI, there is a prompt as shown in [Figure 3-9](#) to help user update the firmware in the USB2ANY. Click the update button to begin the firmware update process. After firmware update succeeds, click the finish button to close the prompt window. Then the GUI tries to connect the EVM board again with the defined device address. After it connects successfully, there is a 3 confirmation sync-up prompt windows, the connected LEDs type (Monochrome or REG), Fail-Safe state (0 or 1) and EEPROM programming Mode (Chip select or External address). For each confirmation window, just click on the correct image mapping to the current EVM setup.



**Figure 3-9. Firmware Update Prompt Window**

If the firmware version of the USB2ANY tool is lower than 2.8.2.0 there is not firmware update prompt as showed in [Figure 3-9](#). Upgrade the firmware version to 2.8.2.0 manually. Go to [USB2ANY Interface Adaptor web page](#), scroll down to "Key Document" section and click "USB2ANY Explorer Software" to download the installation file. Extract the zip file and install the USB2ANY Explorer using the "USB2ANY Explorer-2.8.2.0 Setup" exe file. After USB2ANY Explorer installation, open the software with USB2ANY tool connected to the computer. Please make sure that the GUI is closed while opening the USB2ANY Explorer. After the explorer is opened, there is a "USB2ANY Firmware Requirement" prompt. Click the "OK" button to continue. Follow the instructions on the "USB2ANY Firmware Loader" as showed in [Figure 3-10](#) to update the firmware.

After upgrading the USB2ANY firmware version to 2.8.2.0, close the USB2ANY Explorer and open the TPS929160EVM GUI again. While trying to connect the EVM board, the firmware upgrade window as showed in [Figure 3-9](#) appears.



**Figure 3-10. USB2ANY Firmware Loader**

### 3.4 GUI Function

This section provides instructions to run the TPS929160EVM using the TPS929160EVM GUI.

#### 3.4.1 Connection Status

Make sure to power up the EVM board and connect it to the PC through USB2ANY tool before opening the on-line version GUI or desktop version GUI. If the GUI has been opened but the USB2ANY has not been connected to the PC, make sure the USB2ANY has been connected to the powered-up EVM board when plugging it into the PC. Other operation orders may lead to the GUI working abnormally. After this action happens, please refresh the on-line version GUI or re-run the desktop version GUI.

The GUI supports both hardware setups with CAN board connected or not connected. When CAN board connected, the CAN checkbox on the "Device Address" widget must be checked. When the CAN board is not connected, leave the CAN checkbox unchecked. Before changing hardware setup, remove the USB2ANY cable plug from PC.

Before using the GUI, make sure the hardware is connected successfully. Check the connection status on the home page where there is a green check mark on the left side of the TPS929160-Q1 body, which means the USB2ANY is connected to the computer successfully. If there is a red X mark, it means the hardware is not connected. Reconnect the device.

After hardware is connected, either "Hardware Connected" or "Hardware not Connected" shows on the bottom left corner of the GUI. The button to connect or disconnect the GUI to hardware is also available there. Click the button to connect to hardware if hardware is not connected or to disconnect from hardware while hardware connected.

To connect the GUI to device successfully, set the correct device address on the GUI to map the real device address. See the [TPS929160-Q1 12-Channel Automotive 40-V High-Side LED Driver with FlexWire data sheet](#)

for instructions to set the device address. The default device address setting value of the GUI is 0x01 when you open the GUI.

On the EVM board, the ADDR0, ADDR1, ADDR2 and ADDR3 can be configured as High or Low through "J62", "J63", "J64" and "J65" connectors. On the GUI page you can directly enter the specified value through the "Device Address" widget.

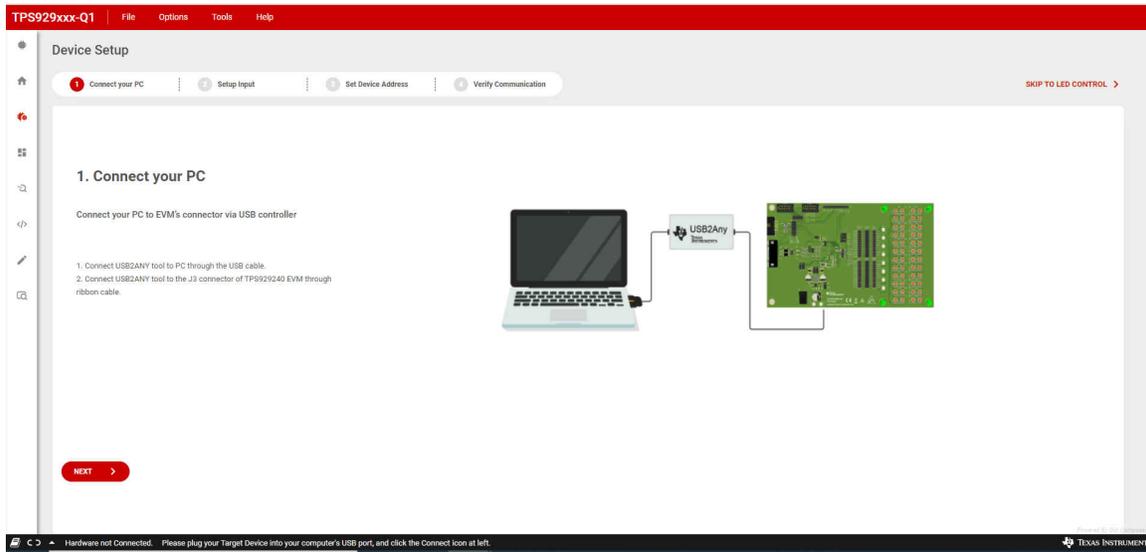


Figure 3-11. TPS929160EVM GUI Connection Status

### 3.4.2 LED Control Page

Figure 3-12 shows the registers page. On the left side, you can select one or more channels to control. On the right side, you can change the current and PWM of the selected channel. The ADC value and error flag is shown on the right. The green button called "Device Configuration" is used to make an advanced setup.

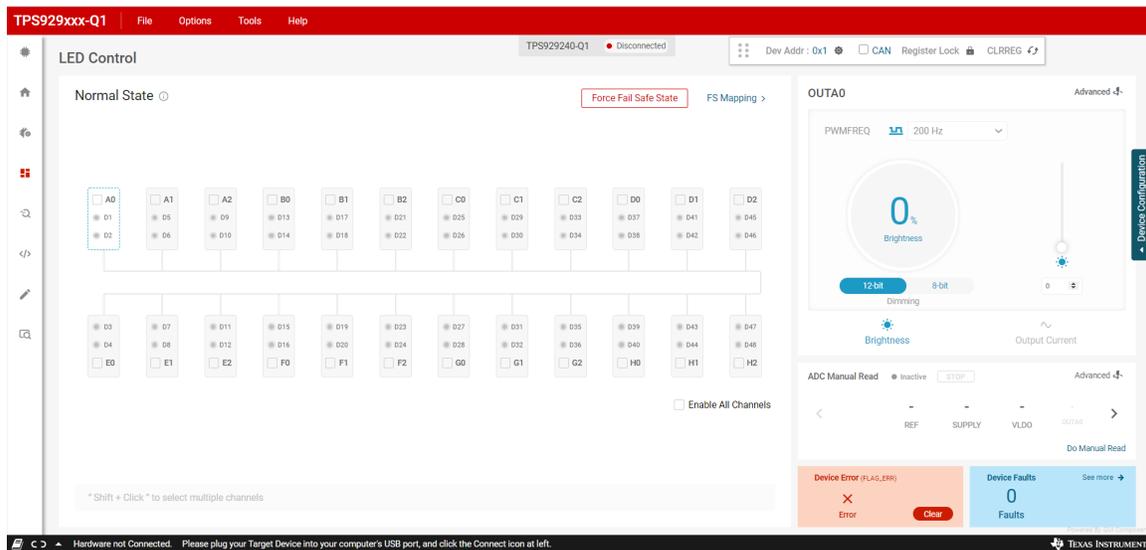


Figure 3-12. TPS929160EVM GUI LED Control Page

### 3.4.3 Diagnostics Page

The diagnostics page monitors the status of each channel of the TPS929160EVM and shows the corresponding protection features.

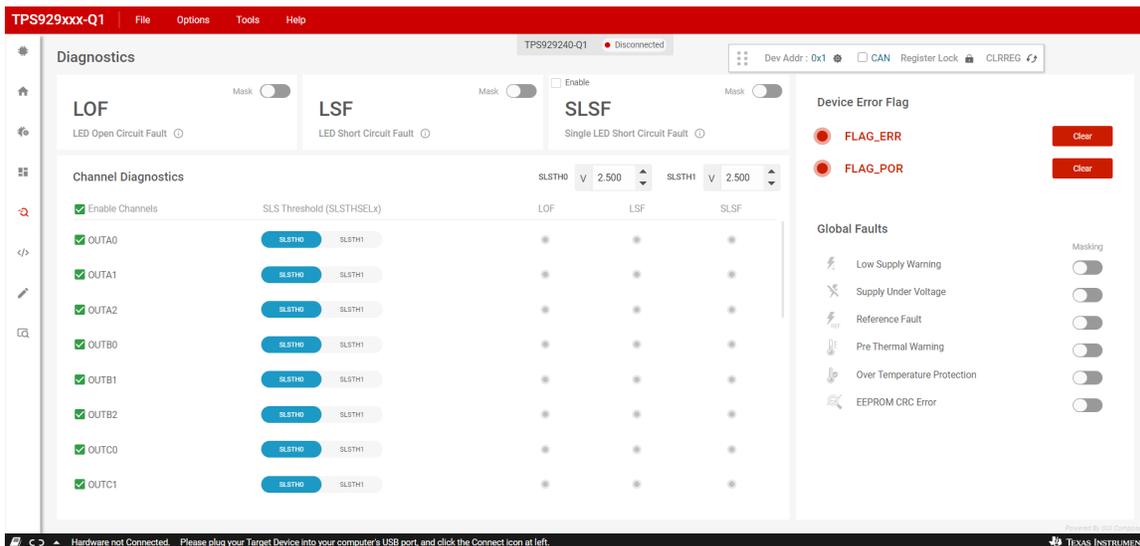


Figure 3-13. TPS929160EVM GUI Diagnostics Page

### 3.4.4 EEPROM Programming Page

The device supports two programming modes for different applications: either with chip select or external address select. Figure 3-14 shows the EEPROM programming page. Click "Enter Programming Mode" to enter the EEPROM mode and change the corresponding register value. "Read EEPROM" is used to get the value from the TPS929160EVM. After changing the value, click "Write EEPROM" button. Then the all the current configuration value really overwrites the corresponding EEPROM registers.

Jumping to other pages from the programming page or clicking "Exit PROG mode" button automatically forces the device exit EEPROM programming mode through clearing CONF\_STAYINEEP method, which means the newly modified EEPROM registers value do not update to corresponding configuration registers after exiting EEPROM programming mode. CLR\_REG can be set through register map page to update configuration registers with the latest EEPROM registers value immediately. For other detailed operation instructions, see the walkthrough wizard of this page.

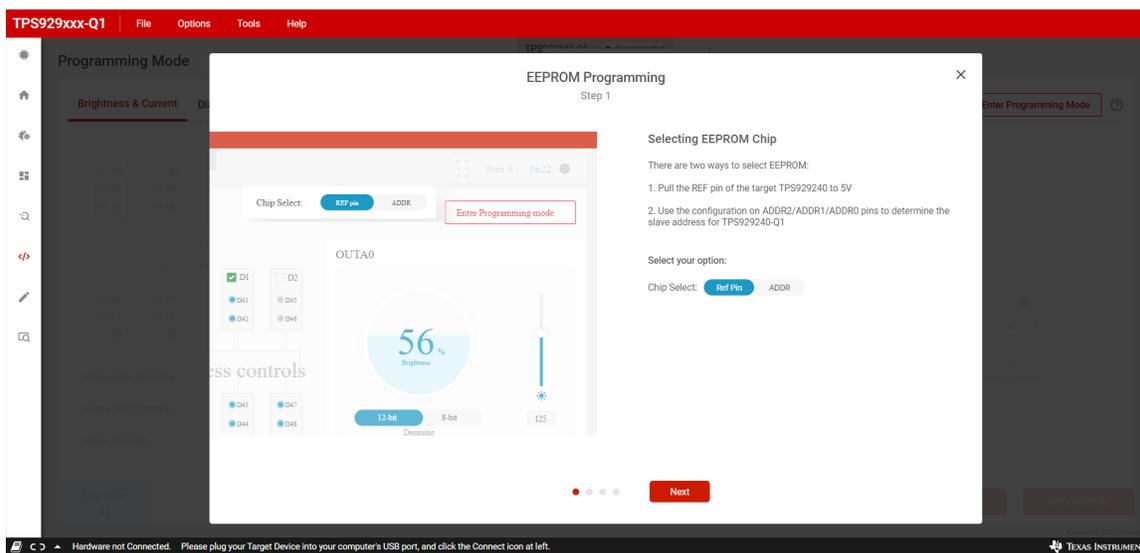


Figure 3-14. TPS929160EVM GUI EEPROM Page

### 3.4.5 Registers Page

Figure 3-15 shows the registers page. All the configuration and EEPROM registers are available on this page. Clicking on the row of the register automatically updates the corresponding field view on the right side of the page. The register value can be modified through clicking the "Value" column or double clicking the "Bits" column. The modified value is effective immediately if "Immediate" function is selected on the top right corner. The modified value does not take effect until you click "WRITE REGISTER" button with "Deferred" function selected. Click "READ REGISTER" button only reads the selected register. All registers' value can be read back or set one time through clicking "READ ALL REGISTERS" or "WRITE ALL REGISTERS".

Modifying the EEPROM registers' value on the register map page does not overwrite the real EEPROM registers' value. Real EEPROM registers' value can be modified only through EEPROM programming page.

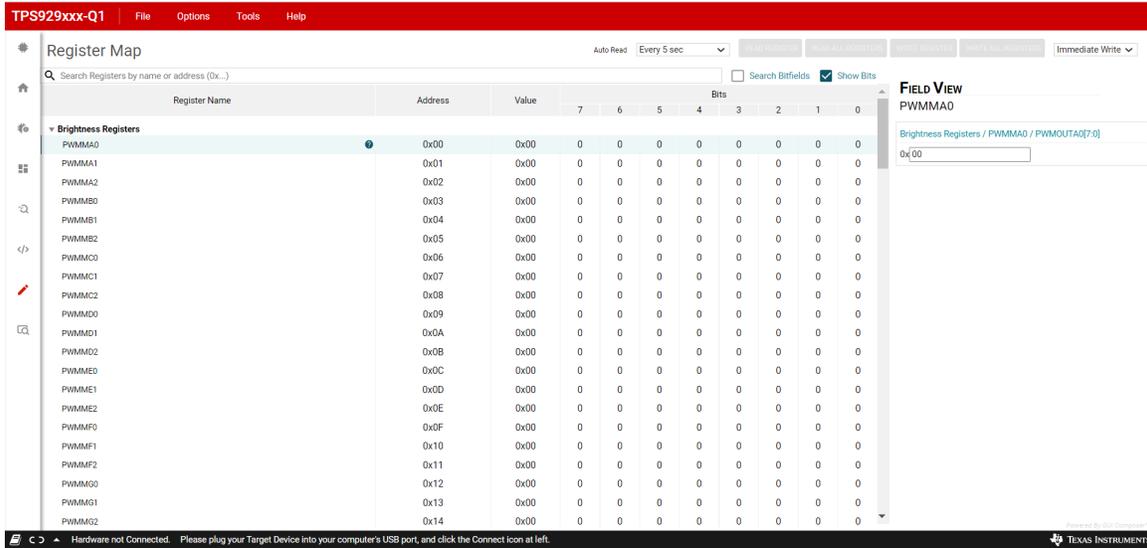


Figure 3-15. TPS929160EVM GUI Register Page

### 3.4.6 Debug Page

Figure 3-16 shows the debug function of the GUI. This function can calculate the corresponding CRC value based on the communication protocol of the TPS929240 and send the complete data. This page allows you to program and debug the TPS929240.

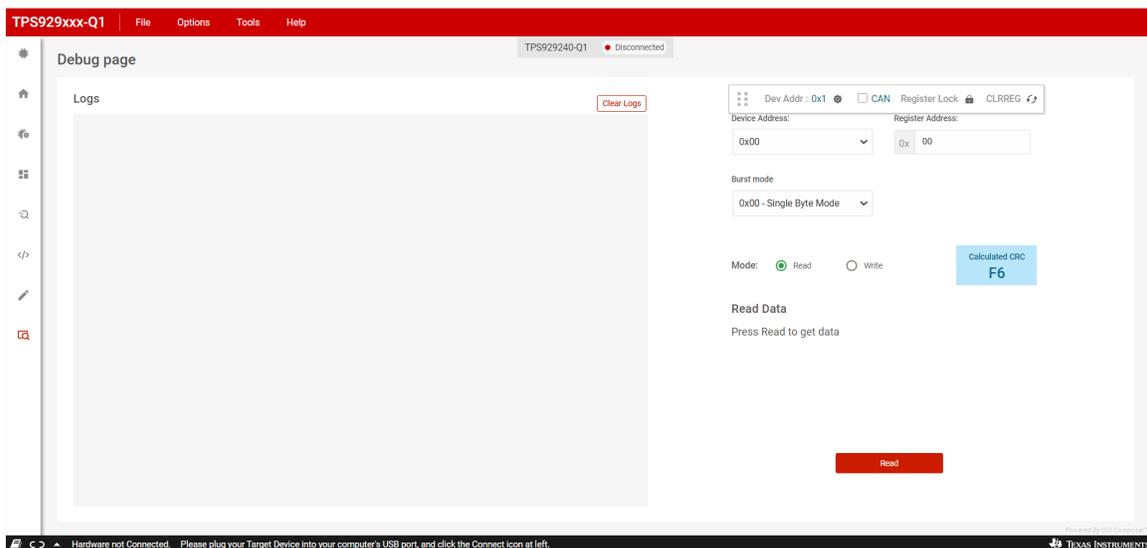


Figure 3-16. TPS929160EVM GUI Debug Page

## 4 Board Layout

Figure 4-1 and Figure 4-2 show the PCB layout of TPS929160EVM.

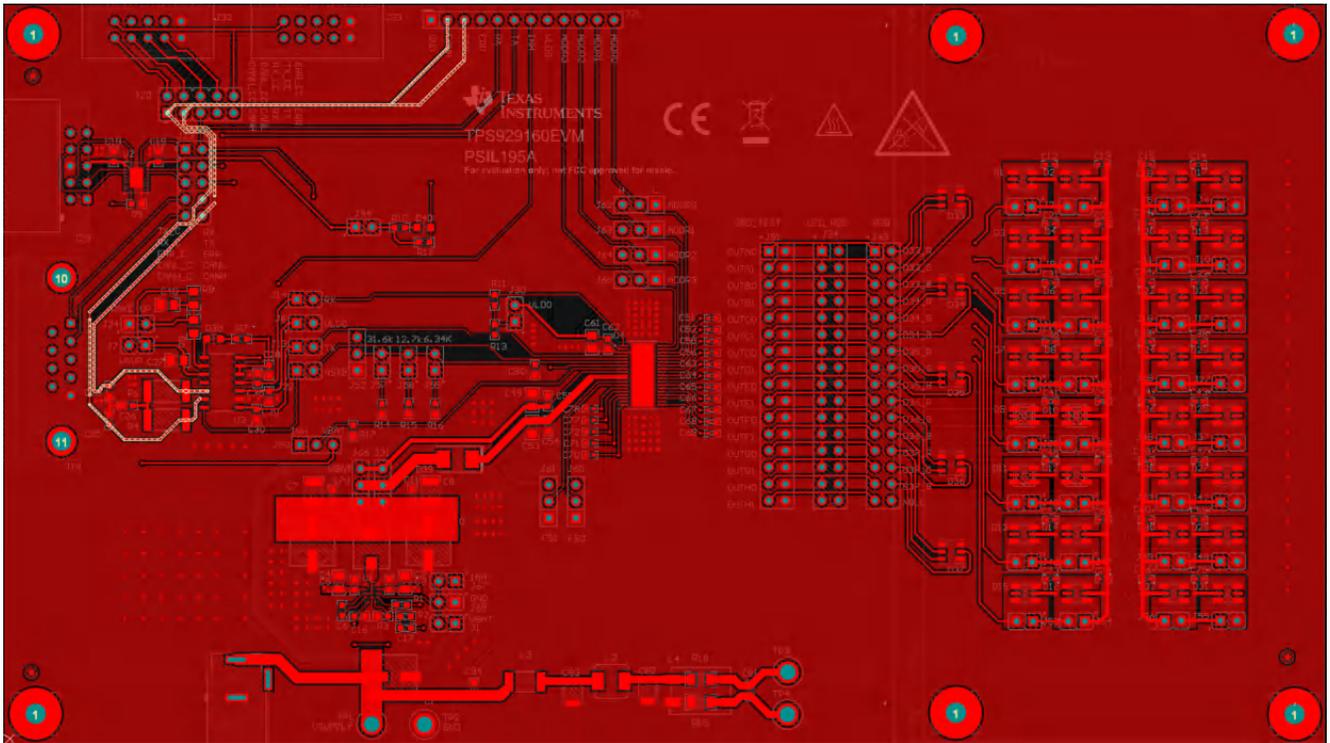


Figure 4-1. Top Layer Routing

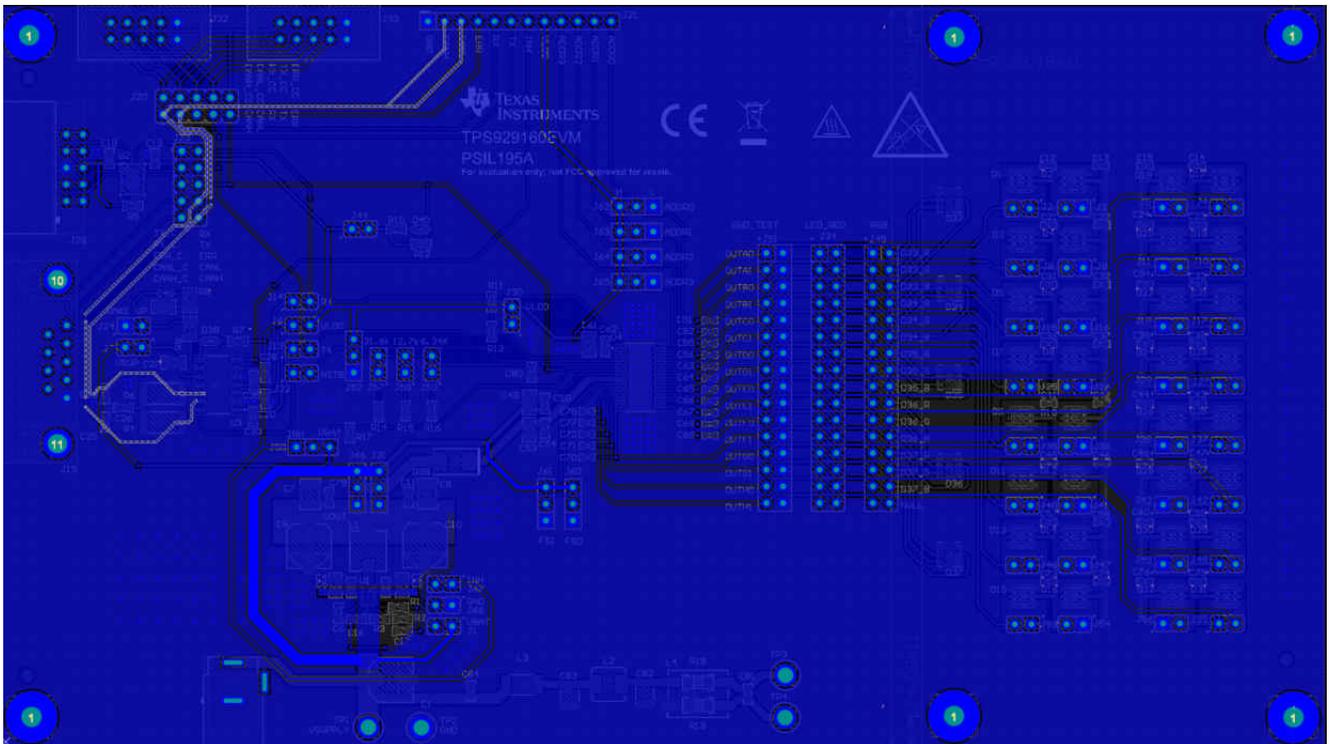


Figure 4-2. Bottom Layer Routing (Mirrored)

### 4.1 Schematic

Figure 4-3 is the TPS929160EVM schematic.

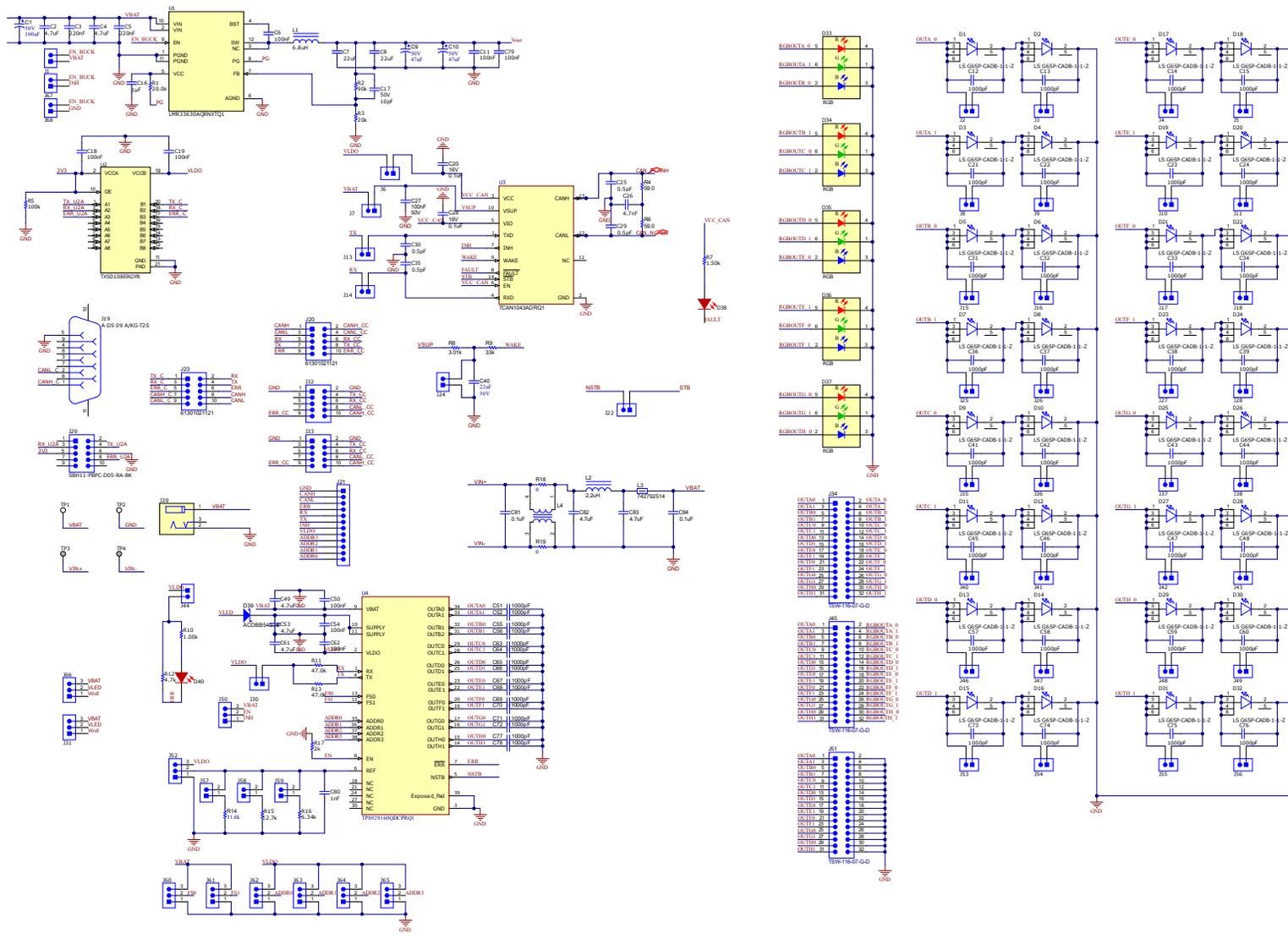


Figure 4-3. TPS929160EVM Schematic Diagram

## 4.2 BOM

Table 4-1 lists the TPS929160EVM BOM.

**Table 4-1. Bill of Materials (BOM)**

DESIGNATOR	QTY	DESCRIPTION	MANUFACTURER	PART NUMBER
C1	1	CAP, AL, 100 uF, 50 V, +/- 20%, 0.34 ohm, AEC-Q200 Grade 2, SMD	Panasonic	EEEFTH101XAP
C2, C4, C49, C53, C61	5	CAP, CERM, 4.7 uF, 50 V, +/- 10%, X5R, 0805	TDK	C2012X5R1H475K125AB
C3, C5	2	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0603	TDK	C1608X7R1H224K080AB
C6, C11, C18, C19, C50, C54, C62, C79	8	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	AVX	06033C104KAT2A
C7, C8	2	CAP, CERM, 22 uF, 25 V, +/- 10%, X5R, 1210	Samsung Electro-Mechanics	CL32A226KAJNNNE
C9, C10	2	CAP, AL, 47 uF, 50 V, +/- 20%, 0.68 ohm, SMD	Nichicon	UUD1H470MCL1GS
C12, C13, C14, C15, C21, C22, C23, C24, C31, C32, C33, C34, C36, C37, C38, C39, C41, C42, C43, C44, C45, C46, C47, C48, C51, C52, C55, C56, C57, C58, C59, C60, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78	48	CAP, CERM, 1000 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	TDK	CGA2B2X7R1H102K050BA
C16	1	CAP, CERM, 1 uF, 25 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGA3E1X7R1E105K080AD
C17	1	CAP, CERM, 10 pF, 50 V, +/- 5%, C0G/NP0, 0603	MuRata	GRM1885C1H100JA01D
C20, C28	2	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0603	Kemet	C0603C104K4RACTU
C25, C29, C30, C35	4	CAP, CERM, 0.5 pF, 50 V, +/- 50%, C0G/NP0, 0603	Kemet	C0603C508C5GACTU
C26	1	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGA3E2X7R2A472K080AA
C27	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 0, 0805	Kemet	C0805C104K5RACAUTO
C40	1	CAP, CERM, 0.022 uF, 50 V, +/- 10%, X7R, 0805	Yageo America	CC0805KRX7R9BB223
C80	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, X7R, AEC-Q200 Grade 1, 0603	Kemet	C0603C102J5RACAUTO
C81, C84	2	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	TDK	CGJ3E2X7R1C104K080AA
C82, C83	2	CAP, CERM, 4.7 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 1210	TDK	CGA6P3X7R1H475M250AB
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22, D23, D24, D25, D26, D27, D28, D29, D30, D31, D32	32	LED, Super Red, SMD	OSRAM	LS G6SP-CADB-1-1-Z
D33, D34, D35, D36, D37	5	LED, RGB, SMD	OSRAM	LRTB GVSG-UEVE-24+AMAQ-29+SCUC-HR
D38, D40	2	LED, Red, SMD	OSRAM	LS R976-NR-1
D39	1	Diode, Schottky, 40 V, 5 A, AEC-Q101, SMB	Comchip Technology	ACDDB540-HF
H1, H2, H3, H4, H9, H10	6	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	B&F Fastener Supply	NY PMS 440 0025 PH
H5, H6, H7, H8, H11, H12	6	Standoff, Hex, 0.5"L #4-40 Nylon	Keystone	1902C

**Table 4-1. Bill of Materials (BOM) (continued)**

DESIGNATOR	QTY	DESCRIPTION	MANUFACTURER	PART NUMBER
H13, H14, H15, H16	4	Standoff, Hex, Male/Female, 4-40, Nylon, 1/2"	Keystone	4802
J1, J2, J3, J4, J5, J6, J7, J8, J9, J10, J11, J13, J14, J15, J16, J17, J18, J22, J24, J25, J26, J27, J28, J30, J35, J36, J37, J38, J40, J41, J42, J43, J44, J46, J47, J48, J49, J53, J54, J55, J56, J57, J58, J59, J67, J68	46	Header, 100mil, 2x1, Gold, TH	Sullins Connector Solutions	PBC02SAAN
J19	1	D-Sub, 2.77mm, 9 Pos, Tin, R/A, TH	Assman WSW	A-DS 09 A/KG-T2S
J20, J23	2	Header, 2.54 mm, 5x2, Gold, TH	Würth Elektronik	61301021121
J21	1	Header, 100mil, 12x1, Gold, TH	Samtec	TSW-112-07-G-S
J29	1	Header(shrouded), 2.54mm, 5x2, Gold, R/A, TH	Sullins Connector Solutions	SBH11-PBPC-D05-RA-BK
J31, J50, J52, J60, J61, J62, J63, J64, J65, J66	10	Header, 100mil, 3x1, Gold, TH	Sullins Connector Solutions	PBC03SAAN
J32, J33	2	Header(shrouded), 2.54mm, 5x2, Gold, TH	Sullins Connector Solutions	SBH11-PBPC-D05-ST-BK
J34, J45, J51	3	Header, 100mil, 16x2, Gold, TH	Samtec	TSW-116-07-G-D
J39	1	WR-DC DC Power Jack, R/A, TH	Würth Elektronik	6.94106E+11
L1	1	Inductor, Shielded, Ferrite, 6.8 uH, 4 A, 0.0762 ohm, SMD	Bourns	SRP5030T-6R8M
L2	1	Inductor, Shielded Drum Core, Powdered Iron, 2.2 uH, 5.5 A, 0.025 ohm, SMD	Vishay-Dale	IHLP2020CZER2R2M11
L3	1	Ferrite Bead, 600 ohm @ 100 MHz, 3 A, 1812	Würth Elektronik	742792514
L4	1	Coupled inductor, 5 A, 0.01 ohm, SMD	TDK	ACM9070-701-2PL-TL01
R1	1	RES, 20.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW060320K0FKEA
R2	1	RES, 100 k, 1%, 0.1 W, 0603	Yageo	RC0603FR-07100KL
R3	1	RES, 24.9 k, 1%, 0.1 W, 0603	Yageo	RC0603FR-0724K9L
R4, R6	2	RES, 59.0, 1%, 1 W, AEC-Q200 Grade 0, 2512	Stackpole Electronics Inc	RMCF2512FT59R0
R5	1	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW0603100KFKEA
R7, R10	2	RES, 1.00 k, 1%, 0.1 W, 0603	Panasonic	ERJ-3EKF1001V
R8	1	RES, 3.01 k, 1%, 0.125 W, 0805	Vishay-Dale	CRCW08053K01FKEA
R9	1	RES, 33 k, 5%, 0.125 W, 0805	Vishay-Dale	CRCW080533K0JNEA
R11, R13	2	RES, 47.0 k, 1%, 0.1 W, 0603	Yageo	RC0603FR-0747KL
R12	1	RES, 4.7 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	Panasonic	ERJ-3GEYJ472V
R14	1	RES, 31.6 k, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060331K6FKEA
R15	1	RES, 12.7 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	Vishay-Dale	CRCW060312K7FKEA
R16, R17	2	RES, 6.34 k, 1%, 0.1 W, 0603	Yageo	RC0603FR-076K34L
R18, R19	2	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	Vishay-Dale	CRCW12060000Z0EA

**Table 4-1. Bill of Materials (BOM) (continued)**

DESIGNATOR	QTY	DESCRIPTION	MANUFACTURER	PART NUMBER
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10, SH-J11, SH-J12, SH-J13, SH-J14, SH-J15, SH-J16, SH-J17, SH-J18, SH-J19, SH-J20, SH-J21, SH-J22, SH-J23, SH-J24, SH-J25, SH-J26, SH-J27, SH-J28, SH-J29, SH-J30, SH-J31, SH-J32	32	Shunt, 100mil, Flash Gold, Black	Sullins Connector Solutions	SPC02SYAN
TP1, TP2, TP3, TP4	4	Terminal, Turret, TH, Double	Keystone	1502-2
U1	1	Automotive 3.8-V to 36-V 3-A Synchronous Step-Down Voltage Regulator, RNX0012B (VQFN-HR-12)	Texas Instruments	LMR33630AQRNXTQ 1
U2	1	8-Bit Bidirectional Voltage-Level Shifter For Open-Drain And Push-Pull Application, RGY0020A (VQFN-20)	Texas Instruments	TXS0108ERGYR
U3	1	Low-Power Fault Protected CAN FD Transceiver with INH and WAKE	Texas Instruments	TCAN1043ADRQ1
U4	1	24-Channel Automotive 40-V High-Side (O)LED Driver	Texas Instruments	TPS929160QDCPRQ 1

## 5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
December 2022	*	Initial release

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